

## CLAIMS

What is claimed is:

1        1. A method for reducing spurious emissions in an amplified signal by applying pre-distortion,  
2        whose magnitude is frequency-dependent, to an input signal to generate a pre-distorted signal, such that,  
3        when the pre-distorted signal is applied to an amplifier to generate the amplified signal, the pre-distortion  
4        reduces spurious emissions in the amplified signal, wherein the pre-distorted signal is generated by:

5        (a) generating a positive-frequency pre-distortion signal corresponding to positive-frequency  
6        components of the input signal;

7        (b) generating a negative-frequency pre-distortion signal corresponding to negative-frequency  
8        components of the input signal; and

9        (c) combining the positive- and negative-frequency pre-distortion signals to generate the pre-  
10       distorted signal.

1       2. The invention of claim 1, wherein the phase of the pre-distortion is also frequency-dependent.

1       3. The invention of claim 1, wherein:

2       the positive-frequency pre-distortion signal is generated by:

3       (1) generating a first set of one or more waveforms corresponding to a first set of one or more  
4       pre-distortion parameters;

5       (2) differentiating the first set of one or more waveforms with respect to time to generate a first  
6       set of one or more differentiated waveforms; and

7       (3) applying the first set of one or more differentiated waveforms to a positive-frequency  
8       operation to generate the positive-frequency pre-distortion signal; and

9       the negative-frequency pre-distortion signal is generated by:

10       (1) generating a second set of one or more waveforms corresponding to a second set of one or  
11       more pre-distortion parameters different from the first set of one or more pre-distortion signals;

12       (2) differentiating the second set of one or more waveforms with respect to time to generate a  
13       second set of one or more differentiated waveforms; and

14       (3) applying the second set of one or more differentiated waveforms to a negative-frequency  
15       operation to generate the negative-frequency pre-distortion signal

1       4. The invention of claim 3, wherein the first and second sets of one or more pre-distortion  
2       parameters are retrieved from look-up tables using an index value based on a power level of the input  
3       signal.

1        5. The invention of claim 4, wherein the power level is a function of  $I^2+Q^2$ , where the input signal is  
2 represented by I and Q signals.

1        6. The invention of claim 3, wherein the positive- and negative-frequency operations are  
2 implemented using filters.

1        7. The invention of claim 3, wherein:  
2        the first set of one or more waveforms is differentiated before being applied to the positive-frequency  
3 operation; and  
4        the second set of one or more waveforms is differentiated before being applied to the negative-  
5 frequency operation.

1        8. The invention of claim 1, further comprising the steps of:  
2        generating a frequency-independent pre-distorted signal from the input signal; and  
3        combining the frequency-independent pre-distorted signal and the positive- and negative-frequency  
4 pre-distortion signals to generate a combined pre-distorted signal.

1        9. The invention of claim 1, wherein:  
2        the input signal is represented in a base-band domain; and  
3        the positive- and negative-frequency pre-distortion signals are generated in a digital domain.

1        10. An apparatus for applying pre-distortion to an input signal to generate a pre-distorted signal, such  
2 that, when the pre-distorted signal is applied to an amplifier to generate an amplified signal, the pre-  
3 distortion reduces spurious emissions in the amplified signal, the apparatus comprising:

4        (a) a main signal processing path adapted to generate a main pre-distortion signal from the input  
5 signal;

6        (b) a positive-frequency secondary signal processing path adapted to generate a positive-frequency  
7 pre-distortion signal corresponding to positive-frequency components of the input signal;

8        (c) a negative-frequency secondary signal processing path adapted to generate a negative-frequency  
9 pre-distortion signal corresponding to negative-frequency components of the input signal; and

10        (d) a combiner adapted to combine the positive- and negative-frequency secondary pre-distortion  
11 signals with the main pre-distortion signal to generate the pre-distorted signal.

1        11. The invention of claim 10, wherein the phase of the pre-distortion is also frequency-dependent.

1        12. The invention of claim 10, wherein:  
2        the main signal processing path is adapted to generate a frequency-independent pre-distorted signal  
3        from the input signal;  
4        the positive-frequency secondary signal processing path is adapted to generate the positive-frequency  
5        pre-distortion signal by:  
6        (1) generating a first set of one or more waveforms corresponding to a first set of one or more  
7        pre-distortion parameters;  
8        (2) differentiating the first set of one or more waveforms with respect to time to generate a first  
9        set of one or more differentiated waveforms; and  
10       (3) applying the first set of one or more differentiated waveforms to a positive-frequency  
11       operation to generate the positive-frequency pre-distortion signal; and  
12       the negative-frequency secondary signal processing path is adapted to generate the negative-  
13       frequency pre-distortion signal by:  
14       (1) generating a second set of one or more waveforms corresponding to a second set of one or  
15       more pre-distortion parameters different from the first set of one or more pre-distortion signals;  
16       (2) differentiating the second set of one or more waveforms with respect to time to generate a  
17       second set of one or more differentiated waveforms; and  
18       (3) applying the second set of one or more differentiated waveforms to a negative-frequency  
19       operation to generate the negative-frequency pre-distortion signal.

1        13. The invention of claim 12, wherein the first and second sets of one or more pre-distortion  
2        parameters are retrieved from look-up tables using an index value based on a power level of the input  
3        signal.

1        14. The invention of claim 13, wherein the power level is a function of  $I^2+Q^2$ , where the input signal  
2        is represented by I and Q signals.

1        15. The invention of claim 12, wherein the positive- and negative-frequency operations are  
2        implemented using filters.

1        16. The invention of claim 12, wherein:  
2        the first set of one or more waveforms is differentiated before being applied to the positive-frequency  
3        operation; and

4 the second set of one or more waveforms is differentiated before being applied to the negative-  
5 frequency operation.

1 17. The invention of claim 12, wherein:

2 the main signal processing path comprises:

3 (1) an index generator adapted to generate index values proportional to envelope power of the  
4 input signal; and

5 (2) a first look-up table adapted to provide first and second pre-distortion parameters using the  
6 index values;

7 the positive-frequency secondary signal processing path comprises:

8 (1) a second look-up table adapted to provide third and fourth pre-distortion parameters using the  
9 index values;

10 (2) a multiplier adapted to multiply the input signal by the third and fourth pre-distortion  
11 parameters to generate first multiplied signals;

12 (3) a differentiator adapted to differentiate the first multiplied signals with respect to time to  
13 generate first differentiated signals; and

14 (4) a positive-frequency filter adapted to filter the first differentiated signals; and

15 the negative-frequency secondary signal processing path comprises:

16 (1) a third look-up table adapted to provide fifth and sixth pre-distortion parameters using the  
17 index values;

18 (2) a multiplier adapted to multiply the input signal by the fifth and sixth pre-distortion  
19 parameters to generate second multiplied signals;

20 (3) a differentiator adapted to differentiate the second multiplied signals with respect to time to  
21 generate second differentiated signals; and

22 (4) a negative-frequency filter adapted to filter the second differentiated signals..

1 18. The invention of claim 10, wherein:

2 the input signal is represented in a base-band domain; and

3 the positive- and negative-frequency pre-distortion signals are generated in a digital domain.